relative temperatures at different places, and Sagredo says that differences of temperature of 100° can be determined; in fact, in one of his letters he says that in the greatest heat of summer his newest thermometer stood at 360°, whereas with a mixture of snow and salt it fell below the extreme cold of winter by about one-third the difference between the extreme atmospheric temperatures of summer and winter. To the present writer it seems most probable that the scale of 360°, used by Sagredo, in 1615, was formed by bending a long narrow glass tube around a graduated circle, or possibly in a spiral around a graduated cylinder, at the lower end of the tube was the bulb filled with a liquid, water or wine, or oil. The Editor believes that some such simple form of the modern liquid thermometer had been suggested to Sagredo by Galileo, so that the pupil speaks of it as the "instrument for measuring heat which you invented, but which I have made in several convenient styles," or again, "which has been improved by me." Dr. Bolton says, on page 30, that "Jean Rey, a physician of southern France, was the first, in a letter of January 1, 1632, to clearly state that he made use of the expansion of a liquid in the bulb of a thermometer." The simple straight thermometer, partly filled with liquid, and sealed at its upper end, was apparently first made by the famous glass blowers of Florence for the use of Ferdinand II, Grand Duke of Tuscany. Dr. Bolton suggests that in this important modification Ferdinand was probably guided by the experiments made by other Florentine savants to show the effects of atmospheric pressure.

In 1642 Galileo died, and in 1657 his pupils were gathered together by Prince Leopold, the brother of Ferdinand II, in an academy known as the Accademia del Cimento. This continued for ten years, and in 1667 the general results of the researches of its members were published by the Prince in classic style. The thermometers used by this academy are known as the Florentine. They simply consisted of a long tube with a spherical bulb at one end and were hermetically sealed at the other. The tube was filled with spirits of wine, because it was more sensitive than water. The coldest temperature of winter corresponded to 20° on the scale and the highest of summer to 80°. The degrees were marked with bits of enamel colored white, black, and green. The alcohol was colored with a solution of kermes or *sanguis draconis*. The principles on which these thermometers were made were certainly understood in Florence in 1641, shortly after which time the Grand Duke Ferdinand had used them when experimenting on the artificial hatching of eggs. About that same time the Duke established a series of meteorological stations, of which we certainly know—

Florence, Pisa, Bologna, Parma, Milan, Innsbrück, and Warsaw. The instruments that were furnished were: Florentine thermometers, Torricelli's barometer, and Ferdinand's hygrometer. These were observed several times daily and records were kept with great fidelity. One of the Italian daybooks, containing sixteen years of observations, was examined by Libri in 1830. The meteorological observations made in Florence from December 15, 1654, to March 31, 1670, were published entire in the introduction to the Archivio Meteorologico Centrale Italiano, Florence, 1858.

The Florentine thermometers were introduced into France by the way of Poland. The Grand Duke Ferdinand had presented some philosophical apparatus to the envoy of the Queen of Poland, and her secretary sent one of these thermometers to the astronometer Ismael Boulliau, in Paris, with the statement that Ferdinand always carried in his pocket a small one, about 4 inches long. It seems likely that this, the first Florentine thermometer seen in England, was brought to the Royal Society in London on the 30th of May, 1663, by the French traveler Monconys, who was visiting the Honorable Robert Boyle, and was brought by him to the meeting of the Royal Society on that date. As late as 1741 Florentine thermometers continued to be used throughout Europe; thus, at Dantzie, in that year, Hanow reported temperatures on the usual Florentine scale, the zero being in the middle of the tube and indicating the average temperature, or about 45° Fahrenheit. In 1730 Réaumur speaks of Florentine thermometers as in common use.

With regard to the Fahrenheit thermometer, Dr. Bolton says:

Daniel Gabriel Fahrenheit was born at Danzig, Prussia, 24th of May, 1686, the son of a well-to-do merchant. After receiving private instruction at home, he attended the gymnasium, but when fifteen years old he had the misfortune to lose both his parents in one day (14th of August, 1701), and was then sent to Amsterdam to enter a business house. There he completed his apprenticeship of four years, but forsook commerce in order to follow his inclination to study physical science and to travel; he became interested in meteorology and acquired great skill in constructing thermometers. In 1714 he visited glassworks in Berlin and Dresden to supervise the manufacture of the tubes for his instruments, and on this journey he called on Professor von Wolf in Halle, as stated.

Returning to Amsterdam he established himself as a maker of philosophical instruments; at that period three distinguished men of science honored Holland, Dr. Hermann Boerhaave, Professor of Medicine and Chemistry in Leyden; Pieter van Musschenbroek, Professor of Mathematics and Physics in Utrecht, and Willem Jacob van's Gravesande, Astronomer and Mathematician at the Hague, and these refer in their writings to Fahrenheit and his thermometers. When he visited England some time prior to 1724, he was well received and honored by election to membership in the Royal Society. Fahrenheit died, unmarried, in the land of his adoption, 16th of September, 1736, at the age of fifty years; he was buried in the Klosterkirche in the Hague.

Fahrenheit's practical work in thermometry began as early as 1706; at first he used alcohol only, but afterwards became famous for his mercury thermometers. In 1709 he sent his instruments to distant places, Iceland and Lapland, and took them in person to Sweden and Denmark. For eighteen years Fahrenheit kept secret his method of manufacture for commercial reasons, but between 1724 and 1726 he published five brief papers in Philosophical Transactions. Many of the experiments date, however, from 1721.

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Fahrenheit made his thermometers with different scales at different times, commonly known as large, medium, and small scales, their correspondence and values being shown in the following table:

I Large.	II Medium.	III Small.	Corresponding Centigrade.
90°	24°	96°	35.5°
0	12	48	8.8
—90	0	0	—17.8

In No. I the zero was placed at "temperate," as in the Florentine scale; in No. II each space was divided into four equal parts, and these smaller divisions were afterwards taken as degrees, thus forming scale No. III.

Dr. Bolton's book closes with a table showing thirty-five thermometric scales, and a brief bibliography.

A BAROMETER NEEDED IN BALLOON VOYAGES.

From Wiedemann's Beiblätter we translate the following summary of an article by K. T. Fischer, published in Vol. I, 1900, pp. 394–396 of the Physikalische Zeitschrift.

The object of the author was to construct an instrument for measuring atmospheric pressure, proper for use in a balloon, that is not affected by the principal errors that the mercurial and the aneroid are subject to in the balloon. The height of the mercurial column ceases to give a simple measure of the atmospheric pressure as soon as the balloon is in a state of accelerated motion, since the column stands too high or too low according as the acceleration is directed downward or upward, respectively. The indications of the aneroid are much deranged by the uncontrolled elastic reaction of the metallic box. Starting with the three conditions, namely, that the desired barometer shall be (1) independent of the acceleration of the balloon, (2) as sensitive as the mercurial, (3) free from elastic reaction, the author has constructed a barometer that may be best characterized as a cartesian diver, whose weight, assuming a constant temperature of the submerged object, is a function of the gaseous pressure prevailing in its interior and may be used to measure the external air pressure. The barometric body consists of a vessel of glass in the shape of an aräometer; at the end of its stem, 30 cm. long, there is an enlargement which contains an opening below and ends in a sphere filled with mercury. The enlargement is hermetically sealed with respect to the space in the tube of the stem. The enlargement is about half full of water, and when enough mercury is introduced into the sphere to cause the aräometer to sink to a definite position of equilibrium in a vessel filled with water, the position satisfies the condition that the quantity of water displaced by the whole body weighs precisely the same as the aräometer. Since the volume of air in the enlargement varies when the external atmospheric pressure varies, therefore under different pressures the aräometer sinks to different depths in the vessel of water. If we keep the external temperature constant, which is best done by placing the aräometer in water with ice, then, by means of a scale placed within the stem, the instrument can be used for measuring the pressure of the air. Experiment shows that this barometer fulfils the three above-mentioned conditions.

The object to be attained by Dr. Fischer is one very much desired by all, but as Professor Marvin has remarked, it will be so difficult to keep the water bath at a constant temperature in a balloon, especially when the water freezes at high altitudes, that the above arrangement will be of little value. The uncertainties due to assuming a constant temperature will always be greater than the errors of the aneroid barometer and it seems more rational to labor to bring the pressure boxes of the aneroid to at least as great perfection as the temperature boxes of the Bourdon thermometer.

The arrangement by Fischer would, we think, be inferior to a simple, straight tube, sealed at the top and open below, immersed in a bath of alcohol, glycerine, or other liquid, and having one or two thermometers closely adjoining. The length of the compressed air column, or rather its volume, and the records of the two thermometers give us the means of allowing for the vapor tension of alcohol and the reduction of the air volume to a standard temperature, whence the pressure becomes known. But, of course, in order to attain an accuracy of one one-hundredth inch of barometric pressure, one must know the volume of air to within one three-thousandth part, which implies knowing its temperature to within one-sixth degree Fahrenheit. This seems at first thought easy, but when the balloon is rapidly rising or falling, the expansion or compression of the air within the tube takes place adiabatically, except in so far as heat may be conducted through the glass tube, and this complicates the determination of the temperature.

LECTURES AND INSTRUCTION.

E. W. McGann, Section Director, delivered a lecture on August 22 before the Farmers' Convention at Jamesburg, N. J., on the Weather Bureau and the State weather service and what they are doing for the farmers. He continued the course of lectures on this subject before the farmers' institutes of New Jersey during the autumn and winter, but owing to the poor heating of the halls at Vineland and Hammerston he contracted a severe cold that temporarily incapacitated him from lecturing; his lecture on December 19, at Caldwell, was very well received.

Under date of November 30, Prof. Wm. M. Fulton reports his attendance at farmers' institutes, at New Market, Clarksville, and Fayetteville, Tenn. The entire middle portion of the State was well represented at these institutes and much interest was manifested by the large audiences in the evening as well as by questions during the sessions in the day time. About two thousand farmers were present, and it is believed that the value of the Weather Bureau to farming interests in this State is being greatly enhanced by the discussions at these meetings.

The institutes held at Memphis, Bell Buckle, and at Nashville during December were very well attended, nearly every county in the State was represented.

Mr. David Cuthbertson, local forecast official at Buffalo, N. Y., lectured before the Men's Club of Lewiston, N. Y., on Friday evening, December 14, and again Saturday morning before the Union School of that city, on the work of the Weather Bureau and its relations to the commercial and marine interests.

Mr. S. S. Bassler, local forecast official, Cincinnati, Ohio, writes that the public schools of that city are now informed by telephone of the forecasts of cold waves, high water, and other meteorological matters, so that the information will reach every home in the city through the children in addition to the usual methods of dissemination.

Mr. Bassler delivered the first lecture of the winter course on December 14, for the Alumni Association of the Bellevue, Ky., High School, on the study of meteorology in the public schools. A large audience paid very close attention.

Mr. J. Warren Smith delivered an address on the work of the Weather Bureau at Lerado, Clermont County, Ohio. The lecture was illustrated and apparently well received. Mr. Smith states that he is really unable to comply with all the requests for lectures before the farmers' institutes, but he has no doubt that such work benefits the public.

On September 21 Mr. A. E. Hackett, Section Director at Columbia, Mo., undertook the instruction of a class in meteorology and climatology in the Missouri State University. The class will meet on Thursdays and Saturdays, one hour each day. The instruction in meteorology will be elementary in character and the work in climatology will be confined to a study of the more important climatic features of the several portions of the United States.

Mr. R. Q. Grant, Observer Weather Bureau, gave a lecture on cyclones and weather forecasting in the Science Building at the State College, Lexington, Ky., Monday, December 10.

THE USE OF THE M. W. REVIEW BY TEACHERS.

We have with much interest noted the steady increase in the circulation of the MONTHLY WEATHER REVIEW among the teachers in high schools, academies, and colleges. We understand that this is largely due to the fact that all the newer text-books on physical geography, physiography, and meteorology, and the journals devoted to those subjects make frequent reference to and quotations from the REVIEW. In fact, Prof. Richard E. Dodge, at the head of the department of geography of the teachers' college in Columbia University, in a recent review of Ward's Practical Exercises in Elementary Meteorology, emphasizes the fact "that the MONTHLY WEATHER REVIEW is an essential aid in good teaching." We take it that this means that both the climatological data and the excellent special contributions from our numerous correspondents are highly appreciated by those who are developing a true system of education, based upon the study of nature and not solely on the language and literature, the abstractions and myths of human invention. One can not acquire a broad education except by going outside of books and studying with enthusiasm the world as it really is, not as man imagines it. That education is most valuable which brings us into close contact with nature, animate and inanimate; with living men and women; with the facts and laws of chemistry and physics.

AERIAL VOYAGES BY BALLOONS AND KITES.

The following interesting letter by A. Lawrence Rotch is copied from Science, December 14, Vol. XII, page 930:

The official report just received of the long-distance balloon race from Paris on October 9 changes somewhat the figures on page 799 of Science, which were those furnished to the press. It appears now that Count de la Vaulx and a companion traveled 1,200 miles in 35 hours and 45 minutes in the basket of a balloon containing only 57,000 cubic feet of illuminating gas. They reached a maximum height of 3¼ miles, crossed Germany and landed in Russia, as did another of the contestants. This is probably the longest continuous voyage in the air ever made, although it was nearly equaled forty years ago by our countryman, John Wise, who, with two companions, went by balloon